



COUNTDOWN ACID RAIN
GOVERNMENT REVIEW OF THE
14TH PROGRESS REPORTS
(JANUARY 31, 1993)
BY ONTARIO'S FOUR MAJOR
SOURCES OF SULPHUR DIOXIDE

AUGUST 1993

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EXECUTIVE SUMMARY

This is the review of the four Countdown companies' 14th semi-annual progress reports, which are required to be submitted under Ontario's acid rain regulations. Each of the four sources has met the legal limits for sulphur dioxide and acid gases (SO₂ plus NO) to date and are in the process of implementing their planned abatement programs to meet 1994 SO₂ emissions targets. Reports were submitted to the Minister of Environment and Energy prior to January 31, 1993 and cover the period July 1 to December 31, 1992.

INCO LIMITED

In 1992, Inco's SO₂ emissions were estimated to be 420 kt (unaudited) with 180 kt emitted in the second half of the year. The mills rationalization program completed in 1991 has been optimized and is currently operating at its design rate. With the process changes currently implemented, Inco's 1992 SO₂ emissions from its Sudbury operations were lower by 157 kt than that of 1991 and 39% lower than the 1992 regulation limit of 685 kt. Inco's current developmental and research plans show that the company is actively working on new technologies to capture SO₂ emissions from the remaining two uncontrolled sources. The construction schedule shows that all planned work in the company's 6th semi-annual progress report of December, 1988 will be completed by December 1993. The report also indicates that the 1994 SO₂ emissions should be within the regulation limit of 265 kt.

FALCONBRIDGE LIMITED

In 1992, the company's SO₂ emissions were estimated to be 54.2 kt (unaudited) which is lower by 65% than the 1992 legal limit of 154 kt. The company reaffirms its current operational capability to meet the 1994 annual SO₂ emissions target of 100 kt at the smelter design capacity. In 1992, the #2 fluid bed roaster hearth was increased to permit higher sulphur removal rates from the concentrate. The company is continuing tests on lower sulphur calcine in the electric furnace and increased sulphur rejection in the mineral processing circuit. The company has so far invested \$30.7 million in the Strathcona mill, smelter and R & D programs. These changes coupled with the proposed research program should enable Falconbridge to meet its voluntary SO₂ emission target of 75 kt at the smelter operational capability before 1998.

ALGOMA STEEL INC.

Algoma's SO₂ emissions from its sinter plant at Wawa were estimated to be 34.2 kt (unaudited), in 1992. These emissions were substantially lower (81%) than the regulated annual limit of

180 kt. The report indicates that the company plans to use lower sulphur iron oxides, mill scales, and other iron/steel industry by-products as sinter plant feed to lower SO₂ emissions from this facility. The company projects that continued use of lower sulphur-containing materials should help to maintain annual SO₂ emissions at less than 60 kt, well below the 1994 limit of 125 kt at the current sinter production level of about 1.0 million tonnes.

ONTARIO HYDRO

Ontario Hydro's unaudited SO₂ and acid gas emissions were estimated to be 157 kt and 209 kt in 1992. Both SO₂ and acid gas emissions were lower by 35% and 25% respectively than Hydro's 1992 emission limits and about 6% lower than 1991 acid gas emissions. The main factors were: decreased primary demand, increased purchases, increased hydraulic generation and also the generation mix resulting from burning lower sulphur coal at Lambton and Nanticoke over higher sulphur coal at Lakeview. In 1992, Hydro spent \$320 million on measures contributing to acid gas control. A major part of the 1992 acid gas control expenditure was for low sulphur coal purchases and the Lambton FGD project. The Lambton flue gas desulphurization (FGD) program is on schedule and commissioning is planned for early 1994. The flue gas conditioning (FGC) system has been declared in-service for the Nanticoke, Lambton and Lakeview generating stations. Remaining derating problems at Nanticoke when using blended coals with less than 0.6% sulphur have been resolved.

INTRODUCTION

Four major corporate sources (Inco, Falconbridge, Algoma at Wawa, and Ontario Hydro) produce over 80% of Ontario's sulphur dioxide (SO_2) emissions. Each source is required by Ontario's Countdown Acid Rain regulations to report every six months on the progress made to reduce SO_2 emissions.

The Countdown program was formulated in 1985 and requires an annual SO_2 emissions cap of 885 kt on all sources in the province, to be in place by 1994. (Ontario is considering lowering its SO_2 emission cap to 877 kt in order to meet the Federal/Provincial agreement of 1985 among 7 eastern provinces to collectively cap SO_2 emissions from these provinces to 2.3 million tonnes after 1993.) Specific reductions in SO_2 for the four companies began in 1986 and culminate in a cap totalling 665 kt by 1994. In the case of Ontario Hydro, limits were also placed on the combined emissions of SO_2 and nitric oxide (NO) and an interim cut of 35% limiting SO_2 to 240 kt and acid gases (SO_2 + NO) to 280 kt was also imposed for 1990-1993. The Countdown limits are in addition to standards imposed to ensure good ambient air quality. Annual legal limits are summarized in Table 1.

Table 1
Sulphur Dioxide Legal Limits
(thousands of tonnes per year)

	<u>1985</u>	<u>1986</u>	<u>1990</u>	<u>1994</u>
Inco nickel/copper smelter, Sudbury	728	685	685	265
Falconbridge nickel/copper smelter, Sudbury	154	154	154	100
Algoma iron ore sintering plant, Wawa	285	180	180	125
Ontario Hydro fossil fuel power plants, province-wide	390	370	240	175
Legal Limits Sub-total :	1,557	1,389	1,259	665

Each of the four sources has met the legal limits to date and each has submitted detailed plans for implementing its reduction program, as required by the regulations. The sixth set of company progress reports, received in December 1988 and January 1989, set out the detailed methods and schedules for meeting the emission limits of the Countdown regulations. They were accepted by the government.

Implementation progress reports are required every six months. This document summarizes the contents of the 14th set of semi-annual company reports and the government response. Previous semi-annual reports are available from the Public Affairs and Communications Services Branch, Ontario Ministry of Environment and Energy, 135 St. Clair Avenue West, Toronto, Ontario, M4V 1P5, (416) 323-4321.

COMPANY REPORTS AND GOVERNMENT RESPONSES

The progress reports were reviewed by the Countdown Technical Support Group (CTSG) drawn from the Ontario Ministries of Environment and Energy and Northern Development and Mines (for the metallurgical companies).

The implementation phase of the Countdown program is progressing very well. A summary of the individual reports and the Ontario government's response follows.

INCO LIMITED

Regulation 660/85 requires a reduction in annual SO₂ emissions from Inco's nickel/copper smelter complex in Sudbury so that emissions will not exceed 265 kt for any year after 1993, compared to the current limit of 685 kt per year. The company was also required to examine the feasibility of going beyond the current limit of 265 kt by 1994 specifically to a level of 175 kt at some future date. Consequently, the feasibility of continuing technical advances remains a concern of Inco and of the government. The government previously accepted Inco's position that a specific interim reduction prior to 1994 was not feasible because of the nature of the major process changes being undertaken to meet the 1994 sulphur dioxide emission limit.

Company Report

The company's 14th progress report covering the period July to December 1992 presents the following points:

- Implementation of the Sulphur Dioxide Abatement Program (SO₂ AP) is continuing as detailed in the report of December 1988 to meet the annual SO₂ emissions target of 265 kt after 1993. Smelter SO₂ AP costs have been revised to \$ 540 million with the total SO₂ Abatement Program to cost about \$ 612 million.
- The Mills Rationalization Program was completed in 1991. Inco had indicated earlier to the CTSG that full benefits of this program will be realised when bulk concentrate smelting becomes fully operational in 1994.
- The construction schedule shows that all planned work detailed in the company's 6th semi-annual report (December, 1988) will be completed by December of 1993. The report also indicates that design engineering is 100% complete and the Smelter Construction Program is about 90% completed as of the end of 1992.

- In 1992, \$40 million were spent on the smelter SO₂ AP. To date, a total expenditure of \$480 million has been incurred on the SO₂ AP.
- During the August-December 1992 period, an average of 380 engineering, construction and management personnel were working on the project except for the month of July 1992 when about 600 personnel were on site.

Operation of Phase I Facilities:

- Operation of the Semi-Autogenous Grinding (SAG) mill, a key component in the Mills Rationalization Program, improved steadily in the latter part of 1992 and throughput approached design capacity.
- The first (# 2 Flash furnace) of the two new oxygen flash furnaces, together with major ancillary facilities, was commissioned in October 1991 and continued to operate steadily. The furnace throughput rate in October and November of 1992 approached the design capacity of 50,000 tons per month based on a combined feed of concentrate and reverts.
- # 2 Flash Furnace technical problems reported in the 13th progress report were resolved and matte, slag and off-gas temperatures were within operating specifications.
- The new double contact acid plant and the ancillary gas cleaning system built for fixing SO₂ from the nickel flash smelting operations has been running well. Removal of some demister acid from the interpass absorption tower has helped Inco to maintain NO_x levels below 5 ppm in the product acid to meet specification requirements.
- No major technical problems were encountered during commercial testwork on tuyere injection of MK material accompanied by O₂ top blowing in #14 converter which was used as a pseudo MK Reactor. During the three month test period several thousand tonnes of MK (copper sulphide) material was processed. Start-up of the new Myren dryer and Macawber pneumatic conveying system was achieved smoothly.
- Installation of high velocity flues and tie-ins to Cotrells (ESPs) and stack fans for three pairs of P-S (Pierce-Smith) converters, designed for converting of bulk flash furnace matte, has been completed and the new system is operational.
- Newly installed DR-300 large flotation cells have enabled Inco to enhance copper/nickel separation efficiency from 30%-45% to 45%-60%, thus reducing the costs for this operation.

Phase II: SO₂ Abatement Program

- Phase II construction work is on schedule and the erection of all steelwork is nearing completion.
- Foundations and steelwork for the second (#1) Flash Furnace have been laid and refractory installation started in January 1993.
- The construction of the MK reactor which will eventually replace the copper flash furnace and associated converting operations is essentially complete except for the modifications related to the injection of MK material through tuyeres.

Government Review

The government review concluded that Inco continues to meet the requirements of Regulation 660/85.

SO₂ Emissions

- Inco's SO₂ emissions for the second half of 1992 were estimated to be 180 kt and for the entire year were 420 kt (unaudited).
- Inco's 1992 SO₂ emissions were 39% below the regulated limit of 685 kt (for 1986-1993) and 152 kt lower than in 1991.
- Lower SO₂ emissions are also likely in 1993 as additional SO₂ abatement systems are put into service.

Mills Rationalization

- The Ministry is pleased to know that Inco was successful in resolving the difficulties experienced earlier with the SAG mill and that this program is operating per the company's expectations.

Smelter

- The Ministry is also pleased to note that Inco has overcome the new # 2 Flash furnace operating problems encountered in the first four months of 1992. The CTSG members would like to be apprised of the possible impact of recycling clean SO₂ bearing off-gases to the flash furnace on sulphuric acid plant operation.

- The Ministry also notes that construction work on the bulk concentrate furnace, (i.e., No. 1 Flash Smelting Furnace) and the MK reactor is on schedule.
- The operation of the prototype MK reactor at Inco's Sudbury facility is progressing satisfactorily and no new major technical problems have been encountered in injecting MK (copper sulphide) material through tuyeres.

Acid Plant

The newly built double contact acid plant and associated gas cleaning system operated without any serious technical problems throughout 1992. It should also be noted that the acid plant and gas cleaning system will be fully integrated with both new flash furnaces upon their completion; hence, without the acid plant, the flash furnaces will not operate and provide further protection to the environment from undesirable SO₂ emissions and/or spills.

General Comments

- The Ministry is pleased to note that Inco has commenced some developmental work in other uncontrolled SO₂ emission areas of smelting operations, namely flash furnace bessemer matte converting and matte processing roasters which contribute to the remaining SO₂ emissions in a major way.
- At Port Colborne, Inco did some pilot tests on continuous converting of flash furnace matte in the latter part of 1992. No major technical problems were encountered and the slags produced were of acceptable composition. However, cobalt recovery was lower than expected. More tests are planned for 1993. If successful, continuous converting of flash furnace matte would enable Inco to maintain sufficient SO₂ concentration in the converter off-gases for sulphuric acid production in the newly built acid plant, thereby further lowering SO₂ emissions from this source.
- In the second area, Inco is investigating the possibility of removing trace metal impurities present in the matte processing roaster off-gases in a gas quenching and scrubber system as well as the disposal of separated wastes in an environmentally satisfactory manner. These roaster gases contain a reasonable strength of SO₂ for fixing in the acid plant but are not sufficiently clean for processing in the acid plant. Plans are being formulated for conducting pilot tests on a slip stream in late 1994 or early 1995 and if successful, another major uncontrolled SO₂ source in Inco's

Sudbury smelting complex could be potentially fixed in the acid plant.

- The Ministry also notes that the company has provided a simplified process flowsheet and a revised sulphur balance in this report in response to earlier requests. The revised sulphur mass balance indicates that Inco expects SO₂ emissions at the projected nickel output to be in the order of 200 kt (assuming a five-week summer shutdown) which is well below the annual SO₂ emission limit of 265 kt effective in 1994.
- The Countdown Technical Support Group found Inco's 14th semi-annual progress report to have a better format and provides more detailed information on areas of interest to the Ministry.

FALCONBRIDGE LIMITED

Regulation 661/85 requires Falconbridge to reduce its annual SO₂ emissions from its Sudbury nickel-copper smelter complex so as not to exceed 100 kt after 1993. The regulation also requires Falconbridge to evaluate the possibility of further reducing SO₂ emissions. Promising areas for further reductions have been identified by the company.

Company Report

The 14th progress report, covering the period July to December 1992, presents the following points:

- The company reaffirms its earlier commitment to meet the 1994 annual SO₂ emission limit of 100 kt at full smelter production capacity. This emission reduction achievement was the result of technical and operational developments by the company such as improved pyrrhotite (Po) rejection, increased degree of roasting and sulphuric acid production, enhanced slag cleaning operation, separate copper concentrate production, and increased smelting of recycled materials supplemented by custom feed.
- Falconbridge will continue to invest capital in the Strathcona mill and smelter. The company anticipates that this investment, coupled with its projected research program, will enable it to meet its voluntary SO₂ emission target of 75 kt at the smelter operational capability before 1998.
- In the second half of 1992 the company emitted about 20 kt of sulphur dioxide due to softer nickel markets with a total annual 1992 SO₂ emissions of 54.2 kt (unaudited). About

91.8% of the sulphur in the nickel/copper ore was fixed in processing and about 20% of sulphur entering the smelter was emitted as SO₂.

- The report also indicates that the capital budget for the process modifications over the period 1989-1993 is estimated at \$23.1 million for capital projects and \$ 10.9 million for research and development in support of the company's SO₂ abatement program. In 1992, \$1.4 million was spent on capital projects in the roasting, acid plant, smelting and converting areas.
- As of the end of 1992, the company has spent over \$30.7 million in capital and R&D program expenditures to meet the Countdown Acid Rain Program SO₂ emission target.
- The report also indicates that in spite of lower international nickel prices, the company does not anticipate any changes or delays in achieving its voluntary SO₂ emissions target of 75 kt/year at the smelter operational capability by 1998.
- All planned smelter modification projects are expected to be in service before the end of 1993 per the current schedule.

- Smelter/Roaster design and operating changes

- # 2 roaster hearth size was increased from 5.6 m to 6.1 m.
- # 2 roaster fan was upgraded in air flow capacity to provide a higher sulphur removal rate in concentrate roasting.
- A new type of electric furnace coke gave better carbon utilization and increased matte metallization.
- Additional furnace tests on increased metallization will be performed in 1993.

- Strathcona Mill Modifications

- Regrinding circuit was upgraded at a cost of \$1.85 million and is expected to provide higher pyrrhotite rejection.
- New magnetic separators will be installed at a cost of \$0.65 million (1993 expenditure \$0.26 million) and when completed would be treating only nickel and copper concentrate from second stage flotation (secondary rougher) for improved Po separation.
- Plans are also under consideration to install larger flotation cells to improve scavenger material flotation in 1994-1995; total costs are estimated to be \$7.3 million.

- R and D Program

- Further work is continuing in the mineral beneficiation areas particularly in developing new flotation agents and their combinations for improvements in Po rejection and concentrate upgrading.
- Operating conditions for treating lower sulphur calcine in the electric furnace are also under investigation.

Government Review

The Countdown Technical Support Group (CTSG) concluded that the company's 14th semi-annual progress report met the requirements of Ontario Regulation 661/85 and that the implementation of the SO₂ abatement program is progressing on schedule. The CTSG is pleased with the technical progress Falconbridge has achieved in meeting its SO₂ emissions limit of 100 kt at full smelter production capacity three years ahead of schedule. The CTSG is further encouraged to note that the company's further investments in R & D and capital projects will likely enable Falconbridge to achieve its goal of an SO₂ emissions level of 75 kt/yr at the smelter operational capacity earlier than 1998.

Additional CTSG comments are as follows:

- The concerns regarding Falconbridge's previous semi-annual reports have been answered.
- The capital expenditures reported in Tables 1.1 and 3.1 have different time spans. Further details in this area would be helpful for the CTSG analysis in the next report.
- The company continues to provide updated flowsheets on various process changes; these and the sulphur balance are helpful in understanding the reported changes and in following the progress of the company's SO₂ Abatement Program.
- CTSG members are also pleased with the company's research and development efforts and the capital program proposed in these difficult economic times, which will provide additional environmental benefits from its voluntary annual SO₂ emissions reduction to 75 kt at the smelter operational capacity before 1998.

ALGOMA STEEL INC.

The Algoma Steel Inc. (Ore Division) operates an iron ore sinter plant at Wawa, about 270 km northwest of Sault Ste. Marie. Regulation 663/85 limits current SO₂ emissions from the operation to 180 kt per year, dropping to no more than 125 kt per year effective 1994.

In August of 1986, the sinter production capacity at Wawa was permanently down-sized by about 50 per cent. When combined with reduced sulphur levels in the feed, this has resulted in substantially reduced SO₂ emissions.

Company Report

The company's 14th semi-annual progress report covering the period July to December 1992 confirms that the company will meet the 1994 SO₂ emission limit by the reduction of sinter capacity. In addition, continued and possibly increased use of low sulphur iron oxides at Wawa could further reduce the level of SO₂ discharged from the sinter plant.

The 14th semi-annual progress report also presents the following points:

- In the second half of 1992 Algoma's SO₂ emissions were 16.8 kt and the annual SO₂ emissions from this source were estimated to be 34.2 kt (unaudited).
- The company forecasts 1993 SO₂ emissions to be about 44.2 kt, at a sinter production capacity of 1.0 million tonnes.
- The company plan indicates that use of low sulphur iron oxides and mill scale in sinter plant feed will be continued and should help to maintain current and projected SO₂ emissions to about 60 kt or less which is well below the 1994 limit of 125 kt.

Government Review

- The CTSG concluded that the company continues to meet the requirements of Regulation 663/85.
- No changes have been reported in the company's plans to meet the 1994 SO₂ emission target of 125 kt.
- The company has not provided in their semi-annual progress reports SO₂ emissions for the appropriate period and general comments on production activity at its Wawa sinter plant as requested earlier.
- The company's claims to pollution prevention measures for reducing SO₂ emissions through increased use of low sulphur iron oxides, mill scales, iron reverts, etc. have to be carefully evaluated in terms of the overall impact on the environment, i.e., total air emissions (SO₂, trace metals, particulates, etc.). A Certificate of Approval, with source testing requirements for trace metals, particulates and various organic compounds, has been issued to the company to ensure acceptable air emissions.

ONTARIO HYDRO

Regulation 355, R.R.O. 1990 (formerly O.Reg. 281/87) requires Ontario Hydro to meet interim annual emission limits for 1990-93 and imposes a tighter limit for 1994 and beyond. Separate limits are set for SO₂ alone and for the sum of SO₂ plus NO (nitric oxide), as shown in Table 2.

Table 2
Ontario Hydro's Sulphur Dioxide and
Acid Gas Emissions Limits

<u>Period</u>	<u>Regulated Limits</u>	
	<u>SO₂</u>	<u>SO₂ + NO</u>
	(kilotonnes per year)	
1986 to 1989	370	430
1990 to 1993	240	280
1994 and future	175	215

Company Report

The corporation reports that in 1992 acid gas emissions (unaudited) were estimated at 157 kt of SO₂ and 209 kt of SO₂ plus NO. SO₂ and acid gas emissions were 35% and 25% below the stated limits for SO₂ and acid gases in 1992; acid gas emissions were also 6% lower than Hydro's 1991 emissions.

The corporation reports expenditures of \$ 320.0 million for the period January to December 1992 on measures contributing to the reduction of acid gas emissions, as follows:

- \$158.0 million was spent for flue gas desulphurization (FGD) for the Lambton Thermal Generating Station (TGS).
- \$1.6 million was incurred for flue gas conditioning at the Lambton, Nanticoke, and Lakeview stations. This measure allows Hydro to burn lower sulphur coal at these locations until suitable control measures are installed.
- \$3.9 million was spent for combustion process modifications.
- \$147.5 million was spent on low sulphur coal premium, which was partly for acid gas control. This is approximately 46% of the total expenditure reported by Hydro for acid gas control in this report.

- \$6.9 million was allotted for compliance with the emissions verification and reporting order issued by the Ministry in June, 1990.
- \$2.3 million was allotted for research and development.
- The report also indicates that the cost of installation of two FGD scrubbers using a limestone slurry system at Lambton is estimated to be \$537.5 million. The FGD program is on schedule and the two Lambton scrubbers are expected to be in-service by early 1994.
- The 14th semi-annual progress report also indicates that the flue gas conditioning (FGC) equipment with sulphur trioxide (SO_3) and ammonia (NH_3) conditioning agents has been working well for all units at Lambton and Nanticoke. The problem of opacity for Nanticoke boilers when using low sulphur coal blends (less than 0.6% sulphur) as fuel was resolved and these boilers are operating at their maximum continuous rating without other environmental problems.
- The FGC systems with SO_3 injection at Lakeview units 5 and 6 are in operation. The upgraded electrostatic precipitators met the suppliers' guarantee for opacity. The FGC system was roughed in for units 1 and 2 which are also equipped with high performance electrostatic precipitators. Units 3, 4, 7 and 8 at Lakeview were removed from service as of April 1993.
- Hydro's current plans are to complete combustion process modifications (CPMs) for unit 4 at Lambton by 1994 and to retrofit the remaining 3 units between 1994-98. Hydro plans to participate with some U.S. utilities to evaluate urea injection and SCR (selective catalytic reduction) technologies for U.S. and Canadian coals. Negotiations with the U.S. utilities are being completed at present.
- The report also indicates that Hydro has installed flue gas monitoring devices (FGMs) on most fossil-fuel boilers in order to meet the Ministry's acid gas (SO_2 and NO) emissions verification and reporting order requirements. Some of the monitors are presently being tested. Also, Hydro is planning a comparison study for a typical unit at the Nanticoke TGS to demonstrate the accuracy of SO_2 and NO emission measurement of FGM system and the in-stack continuous emission rate monitoring (CERM) unit.
- NO_x vs. Load Curves: The report indicates that these curves were developed for four typical units covering Nanticoke, Lambton and Lakeview generating stations in 1992.
- Ontario Hydro has undertaken a major capital program review in recognition of its rapidly changing business environment.

As part of this review Hydro will develop an emission control strategy based on customer and regulatory expectations, environmental impacts, cost of power and social factors.

Government Review

Some points noted by the reviewers are listed below:

- The Countdown Technical Support Group (CTSG) concluded that Ontario Hydro's operations reported in the 14th semi-annual report meet the requirements of Regulation 355 R.R.O. 1990 (formerly O. Reg. 281/87).
- The CTSG noted that more than 70% of the expenditure on acid gas control measures in 1992 was for low sulphur coal purchases and the Lambton FGD project.
- In 1992, Hydro spent \$100 million less on low sulphur coal purchases than in 1991 and nuclear generating stations provided 51.0 % of total electricity generated by Hydro in 1992.
- Under the emissions verification and reporting order, it seems Hydro has charged the total cost of this project to the acid gas control program; this needs to be reviewed as several of these FGMs were considered initially to provide increased combustion efficiency by monitoring NO emissions and would have resulted in fuel cost savings.
- The CTSG found Hydro's 14th semi-annual progress report (January 1993) provided more detailed information on areas of interest to the Ministry.

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